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STORAGE STABLE TRANSLUENT FLAMMABLE ARTICLETECHNICAL FIELD OF THE INVENTION

The invention relates to translucent flammable articles, preferably candles, which are self-supporting and storage stable.

BACKGROUND OF THE INVENTION

Compositions used to make translucent candles have traditionally possessed one or more undesirable characteristics. Most translucent candles do not possess enough rigidity to form a self-supporting candle and need to be housed in some type of supporting container or require some other type of external support. These translucent candles also typically lack hardness, which may lead to a malleable, gelatinous feeling. Some of the most common drawbacks of translucent candles are the phenomena of sweating and syneresis. Sweating is the process whereby oils migrate out of the candle body to the surface, giving it an oily texture, and is most commonly caused by syneresis. Syneresis occurs whenever oil is physically squeezed out from the candle body because of excessive chemical cross linking. The phenomena of sweating and syneresis also contribute to the oily feeling possessed by many of the translucent candle compositions. Syneresis and sweating are highly undesirable qualities in a candle because, among other reasons, 1) consumers don't want to touch a wet, oily candle; 2) the candle becomes more brittle as oil escapes; and 3) the droplets of liquid solvent/additives tend to burn quite quickly once the candle is lit, giving the candle a torch-like quality.

The undesirable characteristics of many translucent candle compositions may also manifest themselves during the burning process. Some compositions used for translucent

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candles do not burn in an aesthetically desirable manner; these compositions may darken or produce black smoke when burning. Other compositions used for translucent candles may not maintain their structural integrity; these  
5 compositions may exhibit external cracking or internal fractures while burning. Still other translucent compositions may exhibit undesirable characteristics during the manufacturing process in the form of cracking or fracturing of the composition. Those translucent candle compositions that lack structural integrity usually are not storage stable, i.e. cannot be stored for long periods of time without the composition exhibiting some structural deterioration. Most commonly this structural deterioration occurs in the form of sweating or syneresis.

15 U.S. Patent No. 6,111,055 (6,111,055) describes a solid composition that may be used as the base material of a translucent candle. The composition includes an ester terminated dimer acid-based polyamide that may be blended with a solvent to form a gel. The gel typically lacks  
20 hardness and has an oily and gelatinous feeling. Thus, a solid coating is also disclosed in 6,111,055 to provide mechanical stability and to eliminate the oily feel of the surface of the gel. The gel disclosed in 6,111,055 noticeably accepts fingerprints and is easily marred when  
25 touched. The candle composition of 6,111,055 also exhibits syneresis and sweating; the solid coating helps to reduce, but does not eliminate, this syneresis. Furthermore, the translucent candle compositions described in 6,111,055 are not storage stable. i.e., they do not maintain their  
30 structural or aesthetic integrity over long periods of time such as when they are stored. Over long periods of time such as during storage the translucent candle composition disclosed in 6,111,055 will exhibit sweating and syneresis.

35 U.S. Patent No. 6,054,517 (6,054,517) describes a clear solid composition that may be used as the base material of a translucent candle. The composition includes one or more

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polyamide resins present in a total amount of about 60 to 80% by weight of the composition, one or more solubilizers, and one or more emulsifiers. The composition described in 6,054,517 is self-supporting and does not have a gelatinous feeling. The composition described in 6,054,517 also is described as burning without cracking or fracturing.

However, the candle compositions described in 6,054,517 are not storage stable, i.e. they do not exhibit stability or maintain their structural or aesthetic integrity over long periods of time such as when they are stored. Specifically, the composition of 6,054,517 will exhibit sweating and syneresis over long periods of time.

Thus, it would be desirable to have a translucent candle composition that was self-supporting, maintained its structural integrity while burning, burned cleanly, the surface of which was not oily to the touch or easily impressed by fingertips, and furthermore was storage stable.

#### SUMMARY OF THE INVENTION

The present invention is directed to a flammable article comprising one or more polyamide gellants selected from the group consisting of fatty polyamides and ester terminated polyamides, one or more solvents, wherein one of the solvents is a fatty acid ester having a carbon chain of between about 9 to about 30 carbons, and one or more solubilizers, wherein one of the solubilizers is a fatty acid having a carbon chain of between about 1 to about 22 carbons. The solubilizer comprises at least 1 % by weight of the composition. The flammable article is storage stable and does not require a supporting container or structure. Preferably, the flammable article also comprises a wick and is a candle. The candle burns cleanly and evenly and is also translucent, preferably transparent.

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Further objects and advantages of the subject invention will be apparent to one of ordinary skill in the art or will be pointed out hereinafter.

DETAILED DESCRIPTION

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Definitions

As used herein "composition" refers to a base material from which the flammable article of the present invention can be made. The composition includes a gellant, a solvent and a solubilizer, all mixed together. The gellant is the component that provides structure to the composition, however, the properties of that structure may be affected by many factors, such as the amount of solvent used and the type and amount of other additives including oils and plasticizers. The solvent binds to the gellant and the solubilizer assists in this coupling; the combination of the gellant, the solvent and the solubilizer provides the flammable article with many of its desirable properties, including clarity, storage stability, and the ability to be self-supporting. In the preferred embodiment of a candle, the combination of the gellant, the solvent and the solubilizer provides the candle with the desirable properties it exhibits when it is burning, such as a flame that burns cleanly, evenly and substantially, without producing excessive amounts of black smoke or darkening the candle itself. However, other factors, such as the size and type of the wick and other components included in the composition, can also impact the burning characteristics of the candle.

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The terms "hydrocarbon" and "hydrocarbyl" as used herein describe organic compounds or radicals consisting exclusively of the elements carbon and hydrogen. These moieties include alkyl, alkenyl, alkynyl, and aryl moieties. These moieties also include alkyl, alkenyl, alkynyl, and

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aryl moieties substituted with other aliphatic or cyclic hydrocarbon groups, such as alkaryl, alkenaryl and alkynaryl. Unless otherwise indicated, these moieties preferably comprise 1 to 20 carbon atoms.

5        The "substituted hydrocarbyl" moieties described herein are hydrocarbyl moieties which are substituted with at least one atom other than carbon, including moieties in which a carbon chain atom is substituted with a hetero atom such as nitrogen, oxygen, silicon, phosphorous, boron, sulfur, or a halogen atom. These substituents include halogen, heterocyclo, alkoxy, alkenoxy, alkynoxy, aryloxy, hydroxy, protected hydroxy, keto, acyl, acyloxy, nitro, amino, amido, nitro, cyano, thiol, ketals, acetals, esters and ethers.

10      Unless otherwise indicated, the alkyl groups described herein are preferably lower alkyl containing from one to eight carbon atoms in the principal chain and up to 20 carbon atoms. They may be straight or branched chain or cyclic and include methyl, ethyl, propyl, isopropyl, butyl, hexyl and the like.

15      20     Unless otherwise indicated, the alkenyl groups described herein are preferably lower alkenyl containing from two to eight carbon atoms in the principal chain and up to 20 carbon atoms. They may be straight or branched chain or cyclic and include ethenyl, propenyl, isopropenyl, butenyl, isobut enyl, hexenyl, and the like.

25      30     Unless otherwise indicated, the alkynyl groups described herein are preferably lower alkynyl containing from two to eight carbon atoms in the principal chain and up to 20 carbon atoms. They may be straight or branched chain and include ethynyl, propynyl, butynyl, isobutynyl, hexynyl, and the like.

35      The terms "aryl" or "ar" as used herein alone or as part of another group denote optionally substituted homocyclic aromatic groups, preferably monocyclic or bicyclic groups containing from 6 to 12 carbons in the ring portion, such as phenyl, biphenyl, naphthyl, substituted

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phenyl, substituted biphenyl or substituted naphthyl. Phenyl and substituted phenyl are the more preferred aryl.

The terms "halogen" or "halo" as used herein alone or as part of another group refer to chlorine, bromine, 5 fluorine, and iodine.

The terms "heterocyclo" or "heterocyclic" as used herein alone or as part of another group denote optionally substituted, fully saturated or unsaturated, monocyclic or bicyclic, aromatic or nonaromatic groups having at least one heteroatom in at least one ring, and preferably 5 or 6 atoms in each ring. The heterocyclo group preferably has 1 or 2 oxygen atoms, 1 or 2 sulfur atoms, and/or 1 to 4 nitrogen atoms in the ring, and may be bonded to the remainder of the molecule through a carbon or heteroatom. Exemplary 10 heterocyclo include heteroaromatics such as furyl, thienyl, pyridyl, oxazolyl, pyrrolyl, indolyl, quinolinyl, or isoquinolinyl and the like. Exemplary substituents include 15 one or more of the following groups: hydrocarbyl, substituted hydrocarbyl, keto, hydroxy, protected hydroxy, acyl, acyloxy, alkoxy, alkenoxy, alkynoxy, aryloxy, halogen, amido, amino, nitro, cyano, thiol, ketals, acetals, esters 20 and ethers.

As used herein, a fatty acid is composed of a chain of alkyl groups containing from 1 to 24 carbon atoms (usually 25 an even number) and characterized by a terminal carboxyl group -COOH. A fatty acid is a carboxylic acid derived from or contained in an animal or vegetable fat or oil. Fatty acids may be saturated or unsaturated (also known as olefinic). A saturated fatty acid is a fatty acid in which 30 the carbon atoms of the alkyl chain are connected by single bonds. Examples of saturated fatty acids include, but are not limited to, butyric ( $C_4$ ), lauric ( $C_{12}$ ), palmitic ( $C_{16}$ ), and stearic ( $C_{18}$ ). An unsaturated fatty acid is a fatty acid in which there are one or more double bonds between the 35 carbon atoms in the alkyl chain. Examples of unsaturated fatty acids include, but are not limited to, oleic ( $C_{18}$ ),

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linoleic ( $C_{18}$ ), and linolenic ( $C_{18}$ ). These acids are usually vegetable derived and consist of alkyl chains containing 18 or more carbon atoms with the characteristic end group - COOH.

Unless otherwise indicated, a fatty acid ester is a fatty acid with the active hydrogen of the -COOH group, the carboxylic acid, replaced by the alkyl group of a monohydric alcohol. The esterification of a fatty acid, RCOOH, by an alcohol, R'OH, yields the fatty acid ester RCOOR'. Thus, R, the "fatty" portion of the fatty acid ester, is composed of a chain of alkyl groups containing from 4 to 22 carbon atoms and may be saturated or unsaturated. A saturated fatty acid ester is a fatty acid ester in which the carbon atoms of R are connected by single bonds. Examples of saturated fatty acid esters include, but are not limited to, butyric ( $C_4$ ), lauric ( $C_{12}$ ), palmitic ( $C_{16}$ ), and stearic ( $C_{18}$ ). An unsaturated fatty acid ester is a fatty acid ester in which there are one or more double bonds between the carbon atoms in R. Examples of unsaturated fatty acids include, but are not limited to, oleic ( $C_{18}$ ), linoleic ( $C_{18}$ ), and linolenic ( $C_{18}$ ).

Unless otherwise indicated, a fatty alcohol is a primary alcohol (from  $C_1$  to  $C_{24}$ ) with a straight or branched alkyl chain. The carbon chain can be saturated or unsaturated. A saturated fatty alcohol is a fatty alcohol in which the carbon atoms of the alkyl chain are connected by single bonds. Examples of saturated fatty alcohols include, but are not limited to, octyl, decyl, lauryl, myristyl, cetyl, and stearyl. An unsaturated fatty alcohol is a fatty alcohol in which there are one or more double bonds between the carbon atoms in the alkyl chain. Examples of unsaturated fatty alcohols include, but are not limited to, oleyl, linoleyl, and linolenyl.

As used herein, "R" means lower alkyl unless otherwise defined.

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Composition Of The Article

Surprisingly, it has been found that the qualities of storage stability, structural integrity, clean and even burning, self-supporting, and a resilient and aesthetically desirable surface can be achieved and the limitations possessed by known translucent flammable articles, specifically transparent candles, can be overcome through the use of a combination of a particular type of solvent with a polyamide gellant and a particular type of plasticizer. Thus, storage stable translucent candles can be made by using a hydrocarbon fatty acid ester between about 9 to about 30 carbons as a solvent in combination with a polyamide gellant and one or more solubilizers that are fatty acids or fatty alcohols. Thus, the composition of the invention contains one or more polyamide gellants, one or more solvents, and one or more solubilizers. The polyamide gellants are preferably fatty polyamides, ester terminated polyamides, or a mixture thereof. The solubilizers are preferably fatty acids having a carbon chain of between about 1 to about 22 carbons or fatty alcohols having a carbon chain of between about 1 to about 24 carbons. The composition may also optionally contain the additional components of hydrocarbon oil, a plasticizer, fragrances and coloring agents.

If a fatty polyamide is used as the polyamide gellant, the composition typically contains from about 10 to about 70 weight % fatty polyamide. Preferably, the composition contains from about 10 to about 50 weight % fatty polyamide. More preferably, the composition contains from about 20 to about 50 weight % fatty polyamide.

If an ester terminated polyamide is used as the polyamide gellant, the composition typically contains from about 10 to about 90 weight % of ester terminated fatty acid. Preferably, the composition contains from about 10 to about 70 weight % ester terminated polyamide. More

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preferably, the composition contains from about 20 to about 50 weight % ester terminated polyamide.

If a mixture of the two types of polyamide gellants is employed in the composition, the composition typically contains between about 10 to about 90 weight % total polyamide gellant. Preferably, when a mixture of polyamide gellants is employed, the composition contains between about 20 to about 70 weight % of total polyamide gellant. More preferably, when a mixture of polyamide gellants is employed the composition contains between about 30 to about 60 weight % of total polyamide gellant.

The composition also contains one or more solvents, which is either a fatty acid ester, a hydrocarbon oil, or mixture thereof. If only one solvent is employed, the solvent is preferably a fatty acid ester solvent having a carbon chain of between about 9 to about 30 carbons. If more than one solvent is employed in the invention, than preferably one of these solvents is a C9 to C30 fatty acid ester.

Irrespective of which type of solvent is used, the total amount of solvent in the composition preferably contains between about 5 to about 70 weight % of total solvent. More preferably, the composition contains between about 10 to about 50 weight % fatty acid ester solvent. Still more preferably, the composition contains between about 10 to about 20 weight % fatty acid ester solvent.

If only a fatty acid ester is employed as the solvent in the invention, the amount of fatty acid ester in the composition is typically between about 5 to about 70 weight % of total solvent. Preferably, the amount of fatty acid ester in the composition is between about 10 to about 50 weight % of total solvent. More preferably, the composition contains between about 10 to about 20 weight % fatty acid ester solvent.

A hydrocarbon oil may also be included in the composition as a solvent. When employed as a solvent in the

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invention, the hydrocarbon oil preferably comprises up to about 50% by weight of the composition. When included, the hydrocarbon oil more preferably comprises about 10% to 40% by weight of the composition. When included, the 5 hydrocarbon oil even more preferably comprises between about 15% to 30% by weight of the composition.

The composition also contains a solubilizer, which is preferably either a fatty acid, a fatty alcohol or combination thereof. The composition preferably contains at 10 least 1% solubilizer by weight. The solubilizer functions to improve the solubility of the polyamide gellant in the solvent, enhancing the coupling of the polyamide gellant to the solvent. This coupling assists in providing the structural integrity, clarity, storage stability and absence 15 of sweating and syneresis properties characteristic of flammable articles and candles made with the composition of the present invention. The composition typically contains from between about 1 to about 75 weight % of solubilizer. The composition preferably contains between about 2 to 30% 20 solubilizer by weight, more preferably about 3-10% solubilizer by weight, and even more preferably 5-7% solubilizer by weight.

The composition may also contain a plasticizer. When used in the composition, the plasticizer preferably 25 comprises between about 0% to about 15% by weight of the composition. More preferably, the plasticizer comprises about 7% to 12% by weight of the composition.

One or more fragrances may also be included in the composition. The total amount of such fragrances in the 30 composition is preferably between about 0-5%, more preferably between about 1-4%, and even more preferably between about 2-3%.

The composition may also include one or more coloring agents. The total amount of such coloring agents in the 35 composition is typically between about 0-5%, preferably between about 1-4%, and more preferably between about 2-3%.

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A preferred embodiment of the flammable article is a translucent candle. The translucent candles are characterized in that they are storage stable, i.e., the candles maintain their structural and aesthetic integrity when stored for significant periods of time. Furthermore, the translucent candles are self-supporting in that they do not require a container or external support, and are capable of burning without such a support. The translucent candles do not produce excessive amounts of black smoke or darken during burning. Additionally, the translucent candles are easily handled and do not require a coating. The surface of the candles is preferably not oily or greasy to the touch, nor is the surface easily marred by fingerprints when the candle is being handled. Rather, the surface of the candles is resilient to the touch and is not easily marred when handled. Thus, candles of the present invention do not require a coating, as do many of the translucent candles of the prior art, for structural support or aesthetic reasons.

A translucent, free-standing and storage stable flammable article may be prepared, for example, using a C<sub>1</sub>-C<sub>22</sub> fatty acid solubilizer in combination with a polyamide gellant and a solvent. In general, the solubilizers facilitate exceptional coupling between the polyamide gellant and solvent. This coupling is believed to assist in providing the structural integrity, clarity, absence of sweating and syneresis and storage stability properties characteristic of flammable articles and candles made with the composition of the present invention. Without being limited to any particular theory, it is presently believed that the coupling between the solvent and polyamide gellant and solubilizer is due to physical bonding between various portions of these components in the form of hydrogen bonding, dipole-dipole interactions, Van Der Waals interactions and related forces.

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Components Of The CompositionSolubilizer

The composition of the invention contains one or more solubilizers. Solubilization is a phenomenon that enables the formation of a solution. It is related to the presence of amphiphiles, molecules possessing the dual properties of being both polar and non-polar, in the solution that have the ability to increase the solubility of materials that are normally insoluble or only slightly soluble, in the dispersion medium. Solubilizers often have surfactant properties. Their function may be to enhance the solubility of a solute in a solution, rather than acting as a solvent, although in exceptional circumstances, a single compound may have both solubilizing and solvent characteristics. The solubilizers useful in the present invention improve the solubility of the polyamide gellant in the solvent. In enhancing the solubility of the polyamide gellant in the solvent, the solubilizer improves the clarity of the gellant/solvent blend. It is believed that the solubilizers also function as a coupling agent, coupling components in the solution and providing the solution with order and stability through physical interactions. These physical interactions can be hydrogen bonding, polar-polar interactions, Van Der Waals interactions and related forces.

Two types of solubilizers are preferred for use with the present invention, fatty acids and fatty alcohols. The hydrocarbon chains of the fatty acid and fatty alcohol can be linear, branched or cyclic and saturated or unsaturated. Solubilizers possessing a branched carbon chain are preferred for use in the invention. The carbon chain of the fatty acids and fatty alcohols is preferably branched in the form of an isopropyl group at the end opposite the carboxylic acid or alcohol functionality. An example of such a carbon chain is isodoctyl. Both the fatty acid

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ester and fatty alcohol are preferably monofunctional; the fatty acid ester is preferably a monofunctional ester (i.e. possessing a single ester moiety) and the fatty alcohol is preferably a monofunctional alcohol (i.e. possessing a single alcohol moiety).

5 Be it fatty acid or fatty alcohol, the solubilizer used in the present invention is preferably a liquid at room temperature. The carbon chain of either the fatty acid or the fatty alcohol is preferably not that long; if the number of carbons in the carbon chain is too high, the solubilizer becomes solid and negatively impacts the clarity of the composition, by causing turbidity. Thus, the carbon chain of the fatty alcohol is preferably between about 1 to about 10 24 carbons. More preferably, the carbon chain of the fatty alcohol is between about 10 to 20 carbons. Still more 15 preferably, the carbon chain is between about 14 to about 18 carbon atoms. Isostearic alcohol is an example of a preferred fatty alcohol.

The carbon chain of the fatty acid is preferably 20 between about 1 to about 22 carbons. Examples include caproic acid, caprylic acid, capric acid, lauric acid, myristic acid, palmitic acid, palmitoleic acid, stearic acid, and isostearic acid. More preferably, the carbon chain of the fatty acid is between about 10 to 20 carbons. 25 Even more preferably, the carbon chain is between about 14 to about 18 carbon atoms. Isostearic acid is an example of a preferred fatty acid. Isostearic acid is a preferred solubilizer for use in the invention due to its compatibility with many of the other components in the 30 composition. When isostearic acid is used as the only solubilizer in the composition, the isostearic acid is typically present in the composition in a total amount of about 1 to 75% by weight, preferably in an amount of about 2 to 30% by weight, more preferably in an amount of about 3- 35 10% by weight, and even more preferably in an amount of about 5-7% by weight.

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A mixture of solubilizers may also be used in the invention; preferably, isostearic acid is present in this mixture. Thus, a mixture of isostearic acid with another solubilizer, either another fatty alcohol or fatty acid, may be used. A preferred mixture is a mixture of isostearic acid and isostearic alcohol. When a mixture of solubilizers is employed, the total amount of solubilizer in the composition is typically between about 1 to about 75% by weight. Preferably, the amount of total solubilizer present in the composition is between about 2 to 30% by weight, more preferably about 3-10% by weight, and even more preferably 5-7% by weight.

In a mixture of solubilizers, isostearic acid is preferably present in a weight ratio of between about 6.5:10 to about 10:10, i.e., 6.5 parts isostearic acid to 10 parts total solubilizer to about 10 parts isostearic acid to 10 parts total solubilizer. More preferably, isostearic acid is present in a mixture of solubilizers in a weight ratio of between about 9.5:10 to about 10:10, i.e., 9.5 parts isostearic acid to 10 parts total solubilizer to about 10 parts isostearic acid to 10 parts total solubilizer.

#### Gellant

The gellants employed in the composition of the present invention are preferably polyamide gellants. Polyamides are polymers that contain recurring amide groups as integral parts of the main polymer chains. If the polymers are formed by the condensation of diamines and dibasic acids, they are called AABB types, and can be represented by the general formula  $H_2NRNH(COR'CONHRNH)_nCOR'COOR''$ , where R and R' are C1-C18, and R'' is either H or C1-C18. If a secondary diamine is used, the general formula above can be N-substituted with an R group. A common form of shorthand symbolism that serves to identify aliphatic polyamides is the use of numbers that signify the number of carbon atoms

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in the respective monomers. For AABB polymers, two numbers are used; the first gives the number of carbon atoms separating the nitrogen atoms of the diamines, and the second gives the number of straight-chain carbon atoms in the dibasic acids. For example, nylon-6,6 is prepared from hexamethylene diamine and adipic acid.

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Polyamides prepared by the self-condensation of an amino acid are called type AB, with the general formula  $H_2NRCO(NHRCO)_n NHRCOOR'$ , where R is an aliphatic carbon chain of any number of carbon atoms, and R' can be R or H. This type of polyamide also uses a number system to identify the composition, but only a single number signifying the number of carbon atoms in the amino acid monomers is used. For example, nylon-6 is polycaprolactam, and nylon-12 is polylauryllactam.

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Two classes of polyamide gellants are preferred for use in the invention. The first class of polyamide gellant is based on vegetable fatty acids and polyamines such as the Versamid<sup>®</sup> series from Henkel corporation, or the UniRez<sup>®</sup> series from Arizona Chemical. This class of polyamides is based on the condensation of (1) diamines with (2) relatively high molecular weight polybasic acids or esters, including dibasic acids or esters, which are obtained from thermal polymerization of a diene acid or ester, such as linoleic acid (for example, linoleates from soy bean, cotton seed or corn oils). The dibasic or polybasic acids are normally mixtures of materials. Typically, the largest component is a dibasic dimeric fatty acid possessing 18 carbon atoms per carboxyl group, but other mono- or polybasic fractions may be present. These mono- or polybasic acids may be a product of the polymerization of unsaturated vegetable oil acids or esters, or they can be deliberately added to the dimer acids, to modify the nature of the resulting polymer. The physical properties of polyamides of this type are determined to a large extent by the identity of the dimer acids used in their production. These

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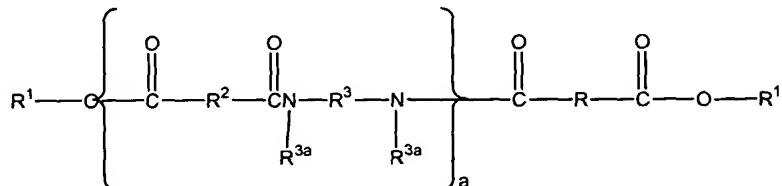
polyamides are also called fatty polyamides, or polyamides from long-chain fatty acids (and esters). These polyamides have greater solubility in selected solvents and lower crystallinity than simpler nylons such as, for example,  
5 nylon-6,6 or nylon-6.

Examples of commercial polyamides which can be used as the polyamide gelling agent in the composition of the present invention are Versamid 1655<sup>®</sup> (by Henkel Corporation, CAS #68915-56-0). Other commercial polyamides which can be used as the polyamide gelling agent include Uni-Rez 2620<sup>®</sup>,  
10 Uni-Rez 2626<sup>®</sup>, and Uni-Rez 2970<sup>®</sup>. The Uni-Rez<sup>®</sup> polyamides are by Union Camp Corporation, and the Versamid<sup>®</sup> polyamides are by Henkel Corporation.

Versamid 1655<sup>®</sup> is prepared from dimers of C<sub>18</sub> unsaturated fatty acids which are partially hydrogenated, azelaic acid (nonanedioic acid), ethylene diamine, hexamethylene diamine and stearic acid. Versamid 744<sup>®</sup> is prepared from dimers of C<sub>18</sub> unsaturated fatty acids, ethylene diamine, hexamethylene diamine and propionic acid. Uni-Rez 2931<sup>®</sup> is prepared from dimers of C<sub>18</sub> unsaturated fatty acids, ethylene diamine and tall oil fatty acids. Versamid 930<sup>®</sup> is prepared from adipic acid and hexylenediamine.

The second type of polyamide gellant is based on complex fatty acids that are terminated by esters such as the UniClear<sup>®</sup> series from Arizona Chemical company. Such a gellant is referred to as an ester-terminated polyamide (ETPA) and comprises molecules of the formula (1):

(1)



wherein n designates a number of repeating units such that  
30 ester groups constitute from 10% to 50% of the total of the

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ester and amide groups; R<sup>1</sup> at each occurrence is independently selected from an alkyl or alkenyl group containing at least 1 carbon atom, preferably at least 4 carbon atoms; R<sup>2</sup> at each occurrence is independently selected from a C<sub>4-42</sub> hydrocarbon group with the proviso that at least 50% of the R<sup>2</sup> groups have 30-42 carbon atoms; R<sup>3</sup> at each occurrence is independently selected from an organic group containing at least two carbon atoms in addition to hydrogen atoms, and optionally containing one or more oxygen and nitrogen atoms; and R<sup>3a</sup> at each occurrence is independently selected from hydrogen, C<sub>1-10</sub> alkyl and a direct bond to R<sup>3</sup> or another R<sup>3a</sup> such that the N atom to which R<sup>3</sup> and R<sup>3a</sup> are both bonded is part of a heterocyclic structure defined in part by R<sup>3a</sup>-N-R<sup>3</sup>, such that at least 50% of the R<sup>3a</sup> groups are hydrogen. For convenience, R<sup>1</sup>, R<sup>2</sup>, R<sup>3</sup> etc. will be referred to herein as "groups", however they could equally well be referred to as radicals (R<sup>1</sup>) and diradicals (R<sup>2</sup> and R<sup>3</sup>).

As may be seen from formula (1), the preferred ETPA gellants have ester groups, i.e., -C(=O)O- groups at both ends of a series of amide groups, i.e., -N(R<sup>3a</sup>)C(=O)- groups. The letter "N" designates the number of repeating units present in a molecule of ETPA, and is an integer greater than 0. N may be 1, in which case the ETPA contains equal numbers of ester and amide groups, i.e., the ester groups constitute 50% of the total of the ester and amide groups in the ETPA molecule. The preferred ETPA gellants are of relatively low molecular weight, so that N is preferably 1 to about 10, and more preferably is 1 to about 5. Due to the low molecular weight of the ETPA molecules, these molecules could also properly be called ester-terminated oligoamides.

The ester groups constitute about 10% to about 50%, preferably about 15% to about 40%, and more preferably about 20% to about 35% of the total of the ester and amide groups. The ETPA gellant of the present invention also includes mixtures of different ETPA molecules described above.

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Indeed, a preferred ETPA gellant includes a mixture of ETPA molecules of formula (1) having various N values.

The R<sup>1</sup> group in formula (1) is an alkyl or alkenyl group which contains at least 1, and preferably at least 4 carbon atoms. Alkyl groups are preferred, however alkenyl groups having 1-3, and preferably 1 site of unsaturation are also suitable.

It is preferred that the number of carbon atoms in the R<sup>1</sup> group be greater than 4, and preferably R<sup>1</sup> has at least about 10 carbon atoms, more preferably at least about 12 carbon atoms, then ETPA is an excellent gellant for aliphatic hydrocarbon. The upper range for the number of carbon atoms in the R<sup>1</sup> group is not particularly critical, however, preferably the R<sup>1</sup> group has less than or equal to about 24 carbon atoms, and more preferably has less than or equal to 22 carbon atoms. R<sup>1</sup> groups having about 16-22 carbon atoms are highly preferred. The identity of R<sup>1</sup> at any occurrence is independent of the identity of R<sup>1</sup> at any other occurrence.

The R<sup>2</sup> group in formula (1) is suitably a hydrocarbon containing 4 to 42 carbon atoms. A preferred R<sup>2</sup> group contains 30-42 carbon atoms (ie., is a C<sub>30-42</sub> group), and at least 50% of the R<sup>2</sup> groups in an ETPA gellant preferably have 30-42 carbon atoms. Such R<sup>2</sup> groups are readily introduced into an ETPA when the gellant is prepared from polymerized fatty acid, also known as dimer acid. Polymerized fatty acid is typically a mixture of structures, where individual dimer acids may be saturated, unsaturated, cyclic, acyclic, etc. Thus, a detailed characterization of the structure of the R<sup>2</sup> groups is not readily available. However, good discussions of fatty acid polymerization may be found in, e.g., U.S. Pat. No. 3,157,681 and Naval Stores--Production, Chemistry and Utilization, D. F. Zinkel and J. Russel (eds.), Pulp. Chem. Assoc. Inc., 1989, Chapter 23.

Typical unsaturated fatty acids used to form polymerized fatty acid include oleic acid, linoleic acid,

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linolenic acid, etc. Tall oil fatty acid, which is a mixture containing long-chain unsaturated fatty acids obtained as a byproduct of the wood pulping process, is preferred for preparing polymerized fatty acid useful in ETPA formation. While tall oil fatty acid is a preferred source of long-chain fatty acid, the polymerized fatty acid may alternatively be prepared by polymerization of unsaturated fatty acids from other sources, e.g., soybeans or canola. The R<sup>2</sup> group containing 30-42 carbon atoms may thus be described as having the structure of dimer or trimer acid, after removal of the carboxylic acid groups (as seen below, the carboxylic acid groups of dimer acid can react to form the amide and/or ester groups of the ETPA gellant).

While the preferred ETPA gellants contain at least 50% C<sub>30-42</sub> groups as the R<sup>2</sup> group, more preferably the total of the R<sup>2</sup> groups consist of at least 75% C<sub>30-42</sub> groups, and still more preferably consist of at least 90% C<sub>30-42</sub> groups. ETPA gellants of formula (1) wherein R<sup>2</sup> is entirely C<sub>30-42</sub> are preferred gellants of the invention.

However, ETPA gellants may also contain R<sup>2</sup> groups having less than 30 carbon atoms. For example, an ETPA gellant may contain one or more R<sup>2</sup> groups having about 4 to 19, preferably about 4 to 12, and more preferably about 4 to 8 carbon atoms. The carbon atoms may be arranged in a linear, branched or cyclic fashion, and unsaturation may be present between any two carbon atoms. Thus, R<sup>2</sup> may be aliphatic or aromatic. When present, these lower carbon-number R<sup>2</sup> groups are preferably formed entirely of carbon and hydrogen, i.e., are hydrocarbon groups. Such lower carbon-number R<sup>2</sup> groups preferably constitute less than 50% of the R<sub>2</sub> groups; however, when present, constitute about 1% to about 50%, and preferably about 5% to about 35% of the total of the R<sup>2</sup> groups. The identity of R<sup>2</sup> at each occurrence is independent of the identity of R<sup>2</sup> at any other occurrence.

The -N(R<sup>3a</sup>)-R<sup>3</sup>-N(R<sup>3a</sup>)- group in formula (1) links two carbonyl (C=O) groups. In a preferred embodiment of the

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invention, all of the R<sup>3a</sup> groups in an ETPA gellant are hydrogen, so that R<sup>3</sup> alone joins the two nitrogen atoms shown in the formula —N(R<sup>2a</sup>)—R<sup>3</sup>—N(R<sup>3a</sup>)—. In this case, the R<sup>3</sup> group contains at least two carbon atoms, and optionally oxygen and/or nitrogen atoms, in addition to any hydrogen atoms that are necessary to complete otherwise unfilled valencies of the carbon, oxygen and nitrogen atoms. In a preferred embodiment, R<sup>3</sup> is a hydrocarbon group, having 2 to about 36 carbon atoms, preferably having 2 to about 12 carbon atoms, and more preferably having 2 to about 8 carbon atoms. These carbon atoms may be arranged in a linear, branched or cyclic fashion, and unsaturation may be present between any two of the carbon atoms. Thus, R<sup>3</sup> may contain aliphatic or aromatic structures. The identities of R<sup>3</sup> and R<sup>3a</sup> at each occurrence are independent of their identities at any other occurrence.

The R<sup>3</sup> groups may contain oxygen and/or nitrogen in addition to carbon and hydrogen atoms. A typical oxygen atom-containing R<sup>3</sup> group is a polyalkylene oxide, i.e., a group having alternating alkylene groups and oxygen atoms. Indeed, the oxygenation in a R<sup>3</sup> group is preferably present as an ether group. Representative polyalkylene oxides include, without limitation, polyethylene oxide, polypropylene oxide and copolymers (either random, alternating or block) of ethylene oxide and propylene oxide. Such oxygenated R<sup>3</sup> groups are readily introduced into an ETPA molecule of the invention through use of Jeffamine™ diamines (Huntsman Chemical, Inc., Houston, Tex.). These materials are available in a wide range of molecular weights. While some of the R<sup>3</sup> groups may contain oxygen (at least about 1%), preferably a minor number (less than 50%) of the R<sup>3</sup> groups contain oxygen, and more preferably less than about 20% of the R<sup>3</sup> groups contain oxygen. The presence of oxygen-containing R<sup>3</sup> groups tends to lower the softening point of the ETPA.

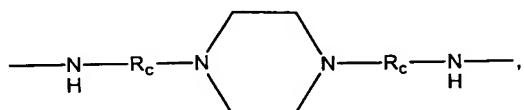
When present, the nitrogen atoms in an R<sup>3</sup> group are preferably present as secondary or tertiary amines. A

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typical nitrogen atom-containing R<sup>3</sup> group having secondary amine groups is a polyalkylene amine, i.e., a group containing alternating alkylene groups and amine groups, which is sometimes referred to as a polyallylene polyamine.

5 The alkylene group is preferably a lower alkylene group, e.g., methylene, ethylene, (ie., -CH<sub>2</sub>CH<sub>2</sub>-), propylene etc. A typical polyallylene amine may be represented by the formula -NH-(CH<sub>2</sub>CH<sub>2</sub>NH)<sub>m</sub>CH<sub>2</sub>CH<sub>2</sub>-NH- wherein m is an integer from 1 to about 5.

10 However, the nitrogen atoms in the nitrogen-containing R<sup>3</sup> group may alternatively (or additionally) be present as tertiary nitrogen atoms, e.g., they may be present in a heterocycle of the formula:



wherein R<sub>c</sub> is a C<sub>1-3</sub> alkyl group.

15 In the above-described nitrogen atom-containing R<sup>3</sup> groups, R<sup>3a</sup> was hydrogen. However, R<sup>3a</sup> is not limited to hydrogen. In fact, R<sup>3a</sup> may be a C<sub>1-10</sub> alkyl group, preferably a C<sub>1-5</sub> alkyl group, and more preferably a C<sub>1-3</sub> alkyl group. In addition, R<sup>3</sup> and R<sup>3a</sup>, or two R<sup>3a</sup> groups, may together form a heterocyclic structure, e.g., a piperazine structure such as



In this case, the two R<sup>3a</sup> groups may be seen as joining together to form an ethylene bridge between the two nitrogen atoms, while R<sup>3</sup> is also an ethylene bridge.

25 The ETPA gellant typically includes a mixture of ETPA molecules of formula (1) in addition to, for example, by-products that are formed during the ETPA-forming reaction. While the ETPA molecules of formula (1) may be purified from such by-products using, e.g., chromatography

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or distillation, the by-products are typically either minimal in amount or impart desirable properties to the gellant, and thus need not be separated from the molecules of formula (1) in order for a suitable ETPA gellant to be formed.

This type of polyamide gellant is commercially available from Arizona Chemical Company as UniClear®. Examples of such commercial ETPA gellants which can be used as the polyamide gelling agent in the composition of the present invention are UniClear 80° (by Arizona Chemical Company), UniClear 80V° (vegetable based UniClear 80° by Arizona Chemical Company), UniClear 100° (by Arizona Chemical Company), and UniClear 100V° (vegetable based UniClear 100° by Arizona Chemical Company).

When UniClear 80° is used as the only polyamide gellant, the UniClear 80° typically totals from about 10 to about 90 weight % of the total composition. Preferably, the UniClear 80° totals from about 10 to about 70 weight % of the total composition. More preferably, the UniClear 80° totals from about 20 to about 50 weight % of the total composition.

A mixture of the fatty polyamides and ester terminated fatty acids may also be employed in the invention. In a polyamide gellant mixture, the fatty polyamide gellant is typically present in a weight ratio of between about 1:11 to about 1:3, i.e., 1 part per weight fatty polyamide gellant to 11 parts total gellant to about 1 part per weight fatty polyamide gellant to 3 part per weight total gellant. Preferably, the fatty polyamide gellant is present in a part per weight ratio of between about 1:10 to about 1:5, i.e., 1 part per weight fatty polyamide gellant to 10 part per weight total gellant to about 1 part per weight fatty polyamide gellant to 5 part per weight total gellant.

In a polyamide gellant mixture, the ETPA gellant is typically present in a weight ratio of between about 2:3 to about 10:11, i.e., 2 parts ETPA gellant to 3 parts total gellant to about 10 parts ETPA gellant to 11 parts total

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gellant. Preferably, the ETPA gellant is present in a weight ratio of between about 7:10 to about 5:6.

### Solvent

The polyamide gellant is combined with a solvent in the composition of the invention to form a gel. The solvent is preferably a low polarity liquid that forms a gel upon being combined with a gellant. The solvents useful in the composition of the present invention can be described generally as belonging to two classes. The first class of solvent is a fatty acid ester and the second class of solvent is a hydrocarbon oil.

A fatty acid ester is a fatty acid in which the terminal carboxylic acid of the fatty acid is replaced by an ester. The fatty acid ester is thus primarily a hydrocarbon containing an ester functionality. Preferably, the fatty acid ester is a liquid having a low polarity. Such esters may be monofunctional esters (i.e. possessing a single ester moiety) or they may be polyfunctional esters (i.e., have more than one ester group).

20 The fatty acid ester solvents preferred for use in the invention can be further classified into four groups, hydrocarbyl fatty acid esters, monoalcohol fatty acid esters and polyol fatty acid esters, fatty acid ester alkoxylates, and sorbitol fatty acid esters.

25        The hydrocarbyl fatty acid esters are fatty acids containing hydrocarbon chains. These hydrocarbyl fatty acid esters are the reaction products of C1-C22 monocarboxylic acids with C1-C22 monoalcohols. The hydrocarbyl fatty acid esters have a carbon chain length of at least about 9 carbons and preferably between about 9 to about 30 carbons. The carbon chain can be linear or branched and may be saturated or unsaturated. More preferably, the carbon chain length of these fatty acid esters is from between about 10 to about 28 carbons. Examples include, but are not limited

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to, fatty acid esters such as isopropyl isostearate, 2-ethylhexylstearate, 2-ethylhexylisostearate, 2-ethylhexylpalmitate, stearic acid, isopropyl stearate, isopropyl myristate, isopropyl palmitate, and isostearyl benzoate. Preferred fatty acid esters of this type include those fatty acid esters in which the "fatty" portion of the fatty acid ester has a carbon chain length of between about 10 to about 24 carbon atoms. Examples of preferred fatty acid ester solvents include 2-ethylhexylstearate, isopropyl stearate, isobutyl stearate, isopropylpalmitate, isobutylpalmitate, 2-ethylhexylpalmitate, and 2-ethylhexylisostearate. More preferred fatty acid esters are those possessing a carbon chain length of between about 16 to about 22 carbons. More preferred fatty acid ester solvents include myristic acid, palmitic acid, and stearic acid.

Mixtures of this type of fatty acid ester solvent can also be used. The fatty acid ester can be mixed with another of the same type of fatty acid ester or a different type of fatty acid ester. Examples of a mixture of this type of fatty acid ester solvent include mixtures of 2-ethylhexylstearate and 2-ethylhexylpalmitate and mixtures of 2-ethylhexylisostearate and 2-ethylhexylpalmitate.

The monoalcohol fatty acid esters are fatty acid esters that are made by reacting a monoalcohol (an alcohol having one alcohol functionality, a monofunctional alcohol) with a fatty acid. A propylene glycol fatty acid ester is an example of a monoalcohol fatty acid ester preferred for use in the invention. Examples include, but are not limited to, propylene glycol myristate, propylene glycol caprilate, propylene glycol dicaprilate, propylene glycol laurate, propylene glycol dilaurate, propylene glycol isotearate, propylene glycol ricinoleate, and propylene glycol tetradecanoate. The propylene glycol fatty acid esters more preferred for use in the invention are those in which the number of carbon atoms of the fatty acid is in the range of

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10 to 22. Propylene glycol myristate and propylene glycol tetradecanoate are more preferred propylene glycol fatty acid esters.

The polyol fatty acid esters are made by reacting a  
5 polyol (an alcohol having more than one alcohol functionality, a polyfunctional alcohol) with a fatty acid. A glycol fatty acid ester is an example of a polyol fatty acid ester preferred for use in the invention. Examples of 10 glycerol fatty acid esters include glycerol dilaurate, glycerol trioleate, glycerol monolaurate, glycerol stearate, glycerol isostearate and glycerol palmitate. The glycerol fatty acid esters more preferred for use in the invention are those in which the number of carbon atoms of the fatty acid is in the range of 10 to 22.

15 The polyol fatty acid esters are made by reacting a polyol (an alcohol having more than one alcohol functionality, a polyfunctional alcohol) with a fatty acid. Preferred parent fatty acids are saturated and unsaturated C10 -C22 fatty acids. Preferred polyol fatty acid esters 20 include glycerol fatty acid esters. Examples of glycerol fatty acid esters include glycerol dilaurate, glycerol trioleate, glycerol stearate, glycerol isostearate, glycerol palmitate, and glycerol monolaurate. Preferred glycerol fatty acid esters include glycerol dilaurate, glycerol 25 trioleate and glycerol monolaurate.

The fatty acid ester alkoxylates are made by reacting alkylene oxides with fatty acids. Preferred parent fatty acids are saturated and unsaturated C12 -C18 fatty acids. Examples include fatty acid ester ethoxylates, fatty acid 30 ester propoxylates, and fatty acid ester butoxylates.

The sorbitol fatty acid esters are derivatives of sorbitan. Examples include sorbitan laurate, sorbitan trioleate, sorbitan palmitate, sorbitan stearate, sorbitan tristearate, sorbitan oleate, and sorbitan sesquioleate. 35 Preferred sorbitol fatty acid esters include sorbitan laurate and sorbitan trioleate. These sorbitan derivatives

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are commercially available from ICI Americas, and are sold under the trademarks SPAN® and ARLACEL®, with various alphanumeric designations for the different derivatives. The sorbitol fatty acid esters have the added benefit of having emulsifying properties. Emulsifiers can improve the solubility of various additives in the composition, such as fragrances or coloring agents, thereby improving the clarity of the composition when such additives are present.

Hydrocarbon oil can also be used as a solvent. The hydrocarbon can be saturated or unsaturated, aliphatic or aromatic, and linear, branched or cyclic. When the solvent is a hydrocarbon oil it functions also as a fuel to provide the flammable article with a substantial flame. If the flammable article is a translucent candle, the hydrocarbon oil serves to provide the candle with a robust and even flame. Thus, the hydrocarbon oil aids in the combustion process. The different types of hydrocarbon oils that can be used in the invention include vegetable oil, animal oil and mineral oil.

Preferably, the hydrocarbon oil is mineral oil, also sometimes referred to as medicinal oil. Mineral oil is a highly refined, colorless, tasteless and odorless petroleum oil (i.e., derived by processing petroleum/crude oil). Such mineral oils are highly refined in having substantially all volatile hydrocarbons removed therefrom, and in being hydrogenated (also called hydrotreated) in order to remove substantially all unsaturation, e.g., aromatic groups have been reduced to the fully saturated analog. A preferred mineral oil to prepare a gel of the invention is so-called "white" mineral oil, which is water-white (i.e., colorless and transparent) and is generally recognized as safe for contact with human skin. Mineral oil may also be characterized in terms of its viscosity, where light mineral oil is relatively less viscous than heavy mineral oil. These terms are defined more specifically in the U.S. Pharmacopoeia, 22nd revision, p. 899 (1990).

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Any mineral oil may be used in the invention. The mineral oil can be light mineral oil or heavy mineral oil. Light mineral oils are preferred for use in the invention. Mineral oils are available commercially in both USP and NF grades. USP mineral oils have viscosities that range from 35 cSt to 100cSt, and pour points that range from -40°C to -12°C. NF light mineral oils have lower viscosities, typically 3-30 cSt, and pour points as low as -45°C. The mineral oil may be of technical grade, having a viscosity ranging from 4-90 cSt and a pour point ranging from -12°C to 2°C. Examples of suitable, commercially available mineral oils include Sonneborn® and Carnation® white oils from Witco, Isopar® K and Isopar® H from Exxon, and Drakeol® and Peneteck® white mineral oils from Penreco.

15

The vegetable oil preferred for use in the invention is triglyceride oil. Examples of triglyceride oils include corn oil, soybean oil, peanut oil, sesame oil, sunflower oil, walnut oil, cottonseed oil, palm oil, rapeseed oil, and castor oil, etc. Castor oil is a preferred vegetable oil.

20

Other hydrocarbon oils that may be used as solvents in the invention include relatively low molecular weight hydrocarbons including linear saturated hydrocarbons such as octane, nonane, decane, undecane, dodecane, tridecane, tetradecane, pentadecane, hexadecane, and octadecane.

25

Other relatively low molecular weight hydrocarbons include cyclic hydrocarbons such as decahydronaphthalene (DECALIN), fuel grade hydrocarbons and branched chain hydrocarbons such as PERMETHYL from Permethyl corporation and ISOPAR from Exxon Corp., including Isopar G, Isopar H, Isopar K, Isopar L, and Isopar M. Aromatic unsaturated hydrocarbon oils can also be used in the invention, such as Hi-Sol 10 and Hi-Sol 15 of Ashland. Hydrocarbon oil mixtures can also be used as solvents such as product PD-23 from Witco (Greenwich, Conn.).

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The amount of hydrocarbon oil solvent in the composition involve considerations regarding the combustion

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and physical integrity and stability of the flammable article. The amount of hydrocarbon oil included in the composition will affect the size and intensity of the flame of the flammable article during combustion. In the 5 situation where the flammable article is a candle, the type of wick employed in the candle also factors into these considerations. The selection of an amount of hydrocarbon oil in the composition and the choice of wick may depend upon the particular type of candle being manufactured. Too 10 much hydrocarbon oil may cause the phenomena of syneresis and sweating to occur; in essence the oil will "bleed out" of the composition if it is present in the composition in too great an amount. Additionally, too little hydrocarbon oil may cause turbidity and reduce the clarity of the 15 composition. Thus, an excessive amount of hydrocarbon oil stands to undermine the physical stability that is achieved by the combination of solvent, polyamide gellant and solubilizer.

In order to prepare a gel from the polyamide gellant 20 and the fatty acid ester solvent, the two components are mixed together and heated until homogeneous. A temperature within the range of about 80-150°C is typically sufficient to allow the gellant to completely dissolve in the solvent. Upon cooling, the mixture forms a gel.

25 Although a "gel" is not easily defined, one skilled in the art readily recognizes a "gel". Generally, a gel is more viscous than a liquid or paste, and retains its shape when left undisturbed, i.e., is self-supporting. However, a gel is typically not as hard as a wax. Gels may be 30 penetrated more easily than a wax-like solid, where "hard" gels are relatively more resistant to penetration than "soft" gels. A rigid gel as defined herein resists deformation upon the application of a force.

Almdale et al. (Polymer Gels and Networks, Vol. 1, No. 35 5 (1993)) list two criteria for defining a system as a gel: (1) a gel consists of two or more components, one of which

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is a liquid, present in substantial quantities, and (2) a gel is a soft material which is solid or solid-like. Thus, the composition of the present invention from which the flammable article is made, with all of the components in 5 addition to the polyamide gellant and the fatty acid ester solvent, meets this definition and can be considered to be a gel.

#### Additional Components

One or more plasticizers may be added to the 10 composition of the present invention. When present, the plasticizers total about 0-15% by weight of the composition, preferably about 7-12% by weight of the composition. A plasticizer is an organic compound added to a polymer both to facilitate processing and to increase the flexibility and 15 durability of the final product by internal modification (solvation) of the polymer molecule. The polymer molecule is held together by secondary valence bonds such as hydrogen bonding, dipole-dipole interactions, and Van Der Waals interactions. The plasticizer replaces some of these 20 interactions with plasticizer to polymer bonds, thus aiding movement of the polymer chain segments. Examples of common plasticizers include nonvolatile organic liquids and low melting solids (such as phthalate, adipate, and sebacate esters), polyols such as ethylene glycol and its 25 derivatives, tricesyl phosphate, castor oil, etc.

Thus, plasticizers function in the present invention to increase the structural flexibility of the composition, allowing the composition to alter its shape instead of cracking or splitting in response to the thermal stresses 30 associated with the burning process. Phthalate esters are preferred for use as plasticizers in the invention. Examples include, but are not limited to, dioctylphthalate, dibutylphthalate, bis(2-ethylhexyl) terephthalate, bis(2-ethylhexyl) adipate, and tris(2-ethylhexyl) trimellitate.

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Suitable plasticizers also include mixtures of these plasticizers. A mixture of dioctylphthalate and dibutylphthalate is a preferred mixture of plasticizers.

The composition of the present invention may also contain one or more fragrances. The fragrances may be those fragrances suitable for use in candles; such type of fragrances will be well known to those of ordinary skill in the art. Examples of such fragrances include, but are not limited to, Citronella AN114351 Sweet Peach, AN 114349 Mountain Berry, AN 114350 Country Garden, AN 114462 Lavender Meadows, AN 114463 Strawberries 'N Cream and AN 114215 Vanilla from Noville Corp., South Hackensack, N.J. The amount of fragrance which should be present in the composition will depend on the intensity of te fragrance and the degree to which it is desired that the composition emit fragrance. This amount can be readily determined by the artisan of ordinary skill, with little or no experimentation.

The compositions of the present invention may also contain a coloring agent, which produces a desired color appearance. A composition having a coloring agent would preferably be translucent and would provide clear color without adding any haziness or cloudiness to the composition. The coloring agents may be those coloring agents suitable for use in candles; such type of coloring agents will be well known to those of ordinary skill in the art. The coloring agent may, for example, be a pigment or a dye, however, a dye is preferred for providing color, especially oil soluble dyes. Oil soluble dyes are well known in the art, and may be obtained from, for example, Pylam Products, Tempe Ariz. Examples of such dyes include, but are not limited to, D&C violet #2, D&C yellow #11, D&C green #6, and D&C red #17.

In the preferred embodiment of a candle, a translucent candle made from the composition preferably has a burn rate of around 4-6 grams per hour, similar to a wax candle. This

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burn rate differs from the burn rate typically seen with a styrene/rubber translucent or clear candle, which has a significantly slower burn rate of around 2 grams per hour. Exemplary candles made from the composition of the present invention include candles with dimensions measuring 2 inches in diameter and 4 inches tall, candles that are 3 inches in diameter and either 3 inches high or 6 inches high.

Preferably, the flammable article burns without darkening or emitting black smoke. It is also preferable that a flammable article made from the composition of the present invention maintains its structural integrity during storage or when burning. In the preferred embodiment of a candle, the candle does not crack or split, nor exhibit sweating or syneresis, nor do the sides of the candle bulge out or experience discoloration in the form of the formation of opaque regions during burning or storage. Furthermore, it is preferred that the flammable article does not superheat and the sides of the candle remain cool to the touch when the article is burning, allowing the article to be handled while burning. It is also preferable that the composition from which the flammable article is made is thermoreversible, that is, after the article has finished burning the molten pool of the composition solidifies and the composition does not experience a significant change in its properties. The flammable article preferably has a high degree of clarity with minimal to no haziness, cloudiness or opaqueness. More preferably, the flammable article is what could be described as crystal clear. This crystal clarity should remain even when additives such as fragrance or coloring agents are added.

Specifically, a candle which has been shown to exhibit minimal to no syneresis or sweating when stored for six months at 30°C is a composition comprising the following weight percents: 50 wt % UniClear 80°, 10 wt% 2-ethylhexylstearate, 5 wt % isostearic acid, and 35 wt % mineral oil. An example of another preferred embodiment of

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the invention that exhibits the properties described above is a candle comprising about 2-10% by weight polyamide gellant; about 20-50% by weight of ester terminated polyamide gellant; about 15-30% by weight of mineral oil; about 10-20% by weight of fatty acid ester, said fatty acid ester comprising a branched carbon chain of between about 10 to about 28 carbons; about 2-10% by weight of isostearic acid; about 0-10% by weight of isostearyl alcohol; about 2-15% by weight of plasticizer; about 1-4% by weight of fragrance; about 1-4% by weight of coloring agent; and a wick. Yet another example of another preferred embodiment of the invention that exhibits the preferred properties described above is a candle comprising about 10-30% by weight polyamide gellant; about 10-70% by weight of ester terminated polyamide gellant; about 10-30% by weight of mineral oil; about 15-50% by weight of fatty acid ester, said fatty acid ester comprising a branched carbon chain of between about 10 to about 28 carbons; about 5-15% by weight of isostearic acid; about 0-10% by weight of isostearyl alcohol; about 10-75% by weight of plasticizer; about 0-5% by weight of fragrance; about 0-5% by weight of coloring agents; and a wick.

The wicks employed in the candle are those wicks typically used with translucent or transparent candles. Candle wicks are commercially available and the wick is selected in consideration of the size of the candle. Preferred wicks are made from uniform, tear-resistant cotton yarn made of medium and long-stapled cotton which is seasoned and does not have moisture damage. A typical wick has from 15-45 strands (plys). Preferably, the wick has from 30 to 43 plys. Examples of preferred wicks include, but are not limited to, 31 ply cotton wicks possessing an approximate burning time of 40 hours, 43 ply cotton with an approximate burning time of 60 hours, and 43 ply cotton with an approximate burning time of 120 hours. A transparent wick may be used so that the entire candle may be

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transparent. Preferably, the wick does not leave ashes upon burning and burns without visible release of soot.

Preferably, the wick has an upright posture upon exiting the candle, with a slight curvature and formation of a glow point at the wick tip upon burning. The selection of an appropriate wick for a given translucent candle is readily made by one of ordinary skill in the art.

The flammable article is generally made by mixing together the polyamide gellant and the fatty acid ester solvent and heating until the mixture is homogeneous. The solubilizer in the composition is added to the mixture at a suitable temperature to assist in achieving a homogeneous mixture. A temperature within the range of about 80-150°C is typically sufficient to allow the gellant to completely dissolve in the solvent. Upon cooling, the mixture forms the composition of the invention. A flammable article may be made from the composition by employing a suitable mold. For example, a candle can be made from the solid composition by employing a mold with a steel bar to provide for the placement of the wick. It is an advantage of the present invention that once cooled, the flammable article can be readily removed from the mold without defacing the surface of the article or experiencing the difficulty with demolding experienced by the prior art.

The invention will now be described in detail with respect to showing how certain specific representative embodiments thereof will be made, the materials, apparatus and process steps being understood as examples that are intended to be illustrative only. Thus, it is understood that the examples are merely illustrative and the invention is not intended to be limited by them.

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**EXAMPLES****EXAMPLE 1**

Transparent candles representative of the present invention were prepared as follows:

5           (1) 2-ethylhexylstearate(2-EHS) was added into a steel container, which was stirred and heated to a temperature of 110 °C.

10           (2) The gellant Versamid 1655° was added little by little, while the content of this container was heated to about 94-96 °C and stirred. During the addition of gellant, isostearic acid was added to obtain a homogeneous solution.

15           (3) The composition, totaling 1 kg in weight, was poured into a mold, which has a steel bar in the center. The composition was allowed to cool to room temperature and solidify. The steel bar was removed. A wick was then threaded through the hole in the composition left by the steel bar.

**EXAMPLE 2**

20           Further transparent candles representative of the present invention were prepared as follows:

25           (1) 2-ethylhexylstearate(2-EHS) was added into a steel container, which was stirred and heated to a temperature of 110 °C.

30           (2) The gellant UniClear 80° was added little by little, while the content of this container was heated to around 94-96 °C and stirred. While the temperature of the composition was around 90°C and during the addition of gellant, isostearic acid was added to obtain a homogeneous solution.

35           (3) The composition, totaling 1 kg in weight, was poured into a mold, possessing a steel bar in the center.

TO COFFEE "GEGENHÖRDT"

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The composition was allowed to cool to room temperature and solidify. The steel bar was removed. A wick was then threaded through the hole in the composition left by the steel bar.

5

## EXAMPLE 3

## General Procedure For Preparation Of Compositions Of Table 1

(1) The solvent was added into a container which was agitated and heated to a temperature of 110°C.

(2) The gellant UniClear 80° was added gradually to the container, while the content of this container was heated to a temperature of around 95-100°C. While the gellant was being added and when the temperature of the container was around 90°C, Isostearic acid was added to obtain a homogeneous solution.

(3) The remaining components were added individually in an order determined by the amount of the component in the composition, with the largest amount being added first. Thus, the fragrance and coloring agent were added last.

(4) The composition was poured into a mold possessing a steel bar in the center. The composition was allowed to cool to room temperature and solidify. The steel bar was removed. The wick was threaded through the hole left by the steel bar.

Using the above procedure, the compositions listed in Table 1 were prepared. The units of Table 1 are weight %.

TOP OFF - 58554700

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25

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TABLE 1

Composition	1	2	3	4	5	6	7	8	9
2-EHS	20	15	20	25	40	50	45		
2-EHP								65	
Gellant 1 1655	40	12							
Gellant 2 2620	5								
Gellant 3 2626	3								
Gellant 4 UniClear 80		27	40	35	32	35	35	20	10
Isostearyl alcohol	5	7		5	8			5	5
Isostearic acid	5	5	10	5	10	5	5		
Plasticizer	10	10							75
Mineral Oil	13		30	30	10	10	10	10	10

Gellant 1: Versamid 1655°

Gellant 2: UniRez 2620°

Gellant 3: UniRez 2626°

Gellant 4: UniClear 80°

## Example 4

## Transparency Measurements

A sample cut in a thickness of 1 cm was placed on printed characters of 12 points to examine if they can be identified through the sample.

The evaluation is as follows: O, clearly identified; Δ, barely identified; and X, unidentified.

Each of compositions 1 through 10 in Example 3 was evaluated using this method.

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10

Composition	Transparency
1	Δ
2	○
3	○
4	○
5	○
6	○
7	○
8	○
9	○
10	○